Technology of load-sensitivity used in the hydraulic system of an all-hydraulic core rig

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Abstract The existing hydraulic system always have problems of temperature rise, running stability and anti-interference of the implementation components, reliability of hydraulic components, maintenance difficulties, and other issues. With high efficiency, energy saving, reliability, easy operating, stable running, anti-interference ability, and other advantages, the load-sensitive hydraulic system is more suitable for coal mine all-hydraulic core rig. Therefore, for the technical development of the coal mine all-hydraulic core rig, the load-sensitive technology employed by the rig should be of great significance.

Keywords all-hydraulic core rig, load-sensitivity, pressure constant control

Introduction

The objective of developing the coal mine rigs is to provide the rigs with highly efficient, easy use, and reliable performance rigs for various geological conditions. Just as any other engineering machines, hydraulic transmission is generally employed by the coal mine rig as a major power transmission mode. This is because the hydraulic transmission has the advantages of high power density, simple structure, small size, speed easily, overload protection, etc. Therefore, the hydraulic system has been playing a vital role in the coal mine all-hydraulic core rig; the levels of the coal mine rig are often determined by the sophistication of the hydraulic system.

With the modernization of the coal mine and the increase of the depth of coal mine gas drainage drilling, the requirements of the coal mine rigs such as reliability, ease in operating, and security also are getting higher and higher.

The mechanical or volume governor speed regulation has always been employed by most traditional coal mine rigs. However, with problems of temperature rise and poor control performance, it is very difficult to meet the requirement of the development of the coal mine rig. With high efficiency, energy saving, high reliability, good operational, and anti-interference ability, the load-sensitive hydraulic system can be employed by the coal mine rigs to improve the performance.

1 The outline of common hydraulic system employed by the rigs

1.1 The way of rotary hydraulic system transmission of the rigs (Huang, 1998; Zhang et al., 1999; Yan et al., 2000; Zhang et al., 2001; Yin and Tian, 2003)

According to the allocation of the pumps and the motors employed by the rig rotary hydraulic system, there are different ways.

1) Quantitative pump-quantitative motor.

It is mechanical speed regulation, not the hydraulic speed regulation, that can be achieved by the system with quantitative pump-quantitative motor.
(Fig.1(a)). The principle is that the drill pipe is driven by the transmission speed devices and the hydraulic motor, clutch, slip gear, and shift agencies are often employed by the transmission devices, while the low-speed torque motors are often used to reduce the number of transmission gear. Even with a simple structure composing of fewer hydraulic components, it being reliable and easy to maintain, and having a low failure rate, this system still have problems that the gear-box size, the overall size, and the weight of the rigs will be inevitably increased by the gear that is in the end of transmission chain and transmit the big torque; CVT cannot be achieved because Gear Shift is a level speed output.

(2) Quantitative pump-variable motor.

The constant output power can be achieved by the system of quantitative pump-variable motor (Fig.1(b)), which means that as the motor speed increases, the torque output declines, and vice-versa, which is in accordance with the characteristic of the rig, and CVT can also be achieved. However, due to the restrictions of the motor displacement, the rigs rotating speed adjustment range becomes narrower and cannot reach the entire rotating speed range; the existing variable motor with more weight, larger size, and higher output speed is bound to lead to more transmission gear and larger size, and it is not conducive to move underground.

(3) Variable pump-variable motor (Huang, 1998; Yin and Tian, 2003)

A wider output speed can be achieved by the rigs with such hydraulic system, and CVT can be achieved in the entire rotation speed range too; but this system can hardly meet the requirements of coal mine's harsh environment because of its complex configuration, high requirements of system reliability and cleanliness, and the size of motors is also its problem (Fig.1(c)).

1.2 The means of hydraulic promoting system of the rig (Huang, 1998; Zhang et al., 1999; Yan et al., 2000; Zhang et al., 2001; Yin and Tian, 2003)

The hydraulic promoting system of the rig is designed to control the drilling pressure. The existing hydraulic promoting system employs the quantitative pump and the throttle to control the speed of promoting indirect to control WOB or with the use of the pressure valve direct to control WOB.

1.2.1 Throttle control WOB

According to the manners of installation, it can be divided into import throttle control and bypass throttle control.

(1) Import throttle control.

Using the import throttle control (Fig.2(a)), the excess supply flow of the pump will flow back to the tank through the relief valve. This system has problems of loss of power and temperature rise, because the pressure of the pump is always the pressure in which the relief valve is set.